08
35
.27

THE BAYLOR BULLETIN

Baylor Business Studies

TWENTY-SEVENTH ISSUE

Use of Statistical Quality Control in Non-Manufacturing Areas

By

JAMES W. PARSONS, JR., Ph.D., C.P.A.

Founded 1845 at Independence
Under the Republic of Texas

THE SCHOOL OF BUSINESS
BAYLOR UNIVERSITY
WACO, TEXAS

Price 50 Cents

JUNE, 1956

JOINT UNIVERSITY LIBRARIES
NASHVILLE, TENN.

Baylor Business Studies

Published Quarterly by the
Committee on Research, School of Business
Baylor University, Waco, Texas

Subscription Price $1.50 Per Year

SCHOOL OF BUSINESS
Aldon S. Lang, Ph.D., Dean

BUREAU OF BUSINESS AND ECONOMIC RESEARCH
William J. Thomas, M.S., Director

Committee on Research

H.N. Broom, Ph.D.,
Professor of Management
Chairman

Billy J. Hinton, Ph.D.,
Associate Professor of
Economics

Neil S. Foster, M.A.
Professor of Marketing

Emerson O. Henke, C.P.A.,
D.B.A.
Professor of Accounting

Aldon S. Lang, Ph.D.
Dean and Professor of Economics

Previous Issues of
BAYLOR BUSINESS STUDIES

1. *New Random Sampling Numbers,* by H. N. Broom, Ph.D.

2. *Presentation of Financial Statements in a Period of Fluctuating Prices,* by Emerson Henke, M.S., C.P.A.

3. *Analysis of Customer Reaction to Waco Retailers,* by Neil S. Foster, M.A.

4. *Population Change in Metropolitan Waco,* by Homer H. Hamner, Ph.D.

5. *Is Your Property Really Yours? A Study in Title Insurance,* by Walstein Smith, Jr., LL.B., M.B.A.

6. *Metropolitan Waco: A Study in Business and Economic Development,* by Floyd F. Burtchett, Ph.D.

7. *The Individual Investor As A Builder of Empire,* by Eleanor Jane Robinson, Ph.D.

8. *Some Major Personnel Problems in a Tightening Labor Market,* by Arch W. Hunt, Jr., M.A.

(Continued on inside back cover)

THE BAYLOR BULLETIN

Baylor Business Studies

TWENTY-SEVENTH ISSUE

Use of Statistical Quality Control in Non-Manufacturing Areas

By

JAMES W. PARSONS, JR., Ph.D., C.P.A.

Founded 1845 at Independence
Under the Republic of Texas

THE SCHOOL OF BUSINESS
BAYLOR UNIVERSITY
WACO, TEXAS

Price 50 Cents

VOLUME LIX JUNE, 1956 NUMBER 11

Published quarterly by Baylor University, and entered at the Post Office at Waco, Texas, as Second Class Mail Matter.

TABLE OF CONTENTS

	Page
Introduction	5
Meaning of Quality Control	5
Meaning of "Statistical" in Statistical Quality Control	8
History of Statistical Quality Control	10
Similarity of Problems of Quality Control in Non-Manufacturing Work To Problems in Industry	12
General Applicability to Non-Manufacturing Work	15
Summary	21
Bibliography	23

EG 9-14-56

PREFACE

Statistical quality control has been in the past and is still being utilized preponderantly in manufacturing industries. However, in this issue of *Baylor Business Studies,* Dr. James W. Parsons pictures to the reader the increasing use of statistical quality control in non-manufacturing areas. Its demonstrated applicability to various non-manufacturing work presumably implies an increasing future reliance of business upon this modern tool of management. Industrial and business processes are increasingly being subjected to more precise scientific controls. Does this presage an accelerated rate in the gradual process of minimizing business risks and a trend toward the professionalization of business through the application of the scientific method? The reader will find the answer here, at least partially.

ALDON S. LANG
Dean of Business School
and Professor of Economics
Baylor University

USE OF STATISTICAL QUALITY CONTROL IN NON-MANUFACTURING AREAS

INTRODUCTION

Historically, statistical quality control has been applied primarily in the manufacturing business. In such applications many benefits have resulted, often with large savings.

The application of statistical quality control to problems of a non-manufacturing nature, or more specifically, to accounting and clerical problems, has lagged. Until recently, little attention has been paid to the broad field of opportunity available in accounting procedures.

This paper explores the accounting procedures in an attempt to determine the similarity of conditions and goals between such procedures and manufacturing procedures and develops the general theory of statistical quality control applied to accounting problems.

Similar conditions and goals exist in accounting areas and in manufacturing areas. Generally stated, the goal of a production process is to provide a quality product at a cost which will enable a profit to be earned upon the sale of the product. The provision of a quality product implies that the rate of defective product should be minimized to the rate inherent within the process. The cost of the product implies that the cost of inspecting the product to determine which units are defective and the cost of reworking defective units will be included in production costs. Similarly, in accounting areas, the product (statements of accounts receivable, balances of accounts in the ledgers, and inventory sheets) should be provided at a cost which does not exceed the benefits derived. There would be a certain error rate which is allowable, and the costs would include inspection (auditing) and correction of errors disclosed by such inspection.

The conclusion reached is that accounting procedures provide opportunities for the application of statistical quality control, and that such applications will be limited only by the individual's imagination and management's willingness to have such applications made.

MEANING OF QUALITY CONTROL

To be able to apply statistical quality control techniques to problems of a non-manufacturing nature it is important, first of all, to examine the applications which have been made. The first

applications were found in the industrial field, or, as generally stated, in "the nut and bolt business." What, then, is quality? What is control? What is quality control? And what is statistical quality control? As in any problem, one of the first steps should be defining the terms to be utilized.

The word "quality" is given a specific meaning in this technical terminology. The basic idea underlying quality control is that the quality refers much more to the *process* than to the product itself. As one writer aptly expressed it, "If a process is capable of meeting the specifications of management, with the economy necessary for maintaining acceptable costs, then the quality of the process is good."[1] Thus it may be seen that the idea of quality entails two separate viewpoints: first, that of management's specifications, which in effect are dictated to some extent by the consumers; and second, that of the cost aspect, which demands that the cost of maintaining the process quality should obviously not exceed the proceeds which will be forthcoming upon sale of the product.

As ordinarily applied in business situations, "control" implies a procedure by which management can accumulate and interpret the facts necessary for determining whether or not business activities are proceeding according to a plan. The application of "control" to the problem at hand would be only one specific usage of the term, which could also apply to such things as "controlling" inventories, "controlling" personnel, and so forth.

What, then, is meant by the combination of the two words? In what sense is the term "quality control" to be used? By combining the specific meanings indicated in the discussion above, the following definition is derived: a procedure by which management can accumulate and interpret the facts necessary for determining whether or not the *process* is proceeding according to a plan.

The nature of quality control in the business organization today might be stated as "a method of measuring the quality of a factory's output against standards that are determined by a consideration of all the factors."[2] What factors are implied by this statement? They would be all factors entering into the operation of a business such as the availability of raw materials, workers and machines,

---

[1]W. B. Rice, "Statistical Quality Control, What It Is and What It Does," *Industrial Quality Control*, III (January, 1946), p. 7.

[2]W. B. Rice, *Control Charts for Factory Management* (New York: John Wiley and Son, 1947), p. 1.

the skill of the workmen, the engineering design, the capabilities of the process, the requirements of the sales department, and the requirements of management in co-ordinating all factors. In short, the fundamental basis of the whole operation would be to produce a maximum profit for the business organization. The factors themselves would and should be subject to changes in order to reach the general profit objective. Economy could be improved in several ways, such as improving the process, improving inspection methods, changing the design, or changing the consumer's idea of what he wants.

To sum up the nature of quality control in the business organization today, it can be stated that "quality control can perhaps better be called profit control."[3]

After reading the material presented so far, the layman would probably have the conception that quality is "inspected" into the product by having an inspector at the end of the process to pick out the defective units of product. The concept of quality control as applied in business today is based on the idea that quality cannot be "inspected" into the product. One of the fundamentals is that trouble should be *prevented*. One writer in the field states: "The trouble—whether it be illness, fire, crime, or defective industrial product quality—should be prevented rather than corrected after it has occurred."[4] Assuming quality raw material with which to start, the "building" of quality must start with the workmen themselves. One of the best places to institute quality control is in the indoctrination of the new worker. When he is hired, it is extremely important to convince him that he is an integral part of the business organization. Since the consumer will pay his salary, he (the employee) should strive to produce full satisfaction for the consumer. This can be done only through strict adherence to specifications, which in turn are a fundamental part of quality control. Old workers are encouraged to produce at an increased rate, but only through the more efficient use of their abilities, not through sacrifice of quality for quantity's sake.

Some indication should be given as to the general steps necessary in the adoption of such a plan. W. B. Rice, one of the early writers in the field of statistical quality control, has indicated that

[3]Rice, "Statistical Quality Control, What It Is and What It Does," p. 8.
[4]A. V. Feigenbaum, *Quality Control: Principles, Practice, and Administration* (New York: McGraw-Hill Book Company, 1951), p. 28.

there are three general steps to be instituted. First of all, basic facts, which must be not only accurate, but also adequate, are gathered, analyzed and interpreted. Secondly, from the facts and the conclusions drawn from them management should set standards of quality for the outgoing product. Finally, there must be set up a control procedure to insure that operations are being conducted at the desired level, and that significant variations from this level are corrected promptly.[5]

MEANING OF "STATISTICAL" IN STATISTICAL QUALITY CANTROL

As indicated in the preceding section, "quality control" in essence is a system designed to improve and maintain quality in a production process with the end result of affording the entire organization a profit. In what sense does the addition of the adjective "statistical" quality or supplement this definition? E. L. Grant, one of the pioneers in publications on statistical quality control, indicates that the usage of the adjective "statistical" implies that the method is based to a large extent on the law of large numbers and on the mathematical theory of probability.[6] The term "statistical quality control" would then entail "the application of statistical methods as a scientific technique for collecting and analyzing the data, for setting the standards, and for maintaining adherence to the standards."[7]

The concept of the statistical quality control viewpoint is summed up by Grant as follows:

> "Measured quality of manufactured product is always subject to a certain amount of variation as a result of chance. Some stable 'system of chance causes' is inherent in any particular scheme of production and inspection. Variation within this stable pattern is inevitable. The reasons for variation outside this stable pattern may be discovered and corrected."[8]

The implications of this summarization are twofold; first, there is the phenomenon of inherent variation in any process; second, perfection (in the sense of no variation) is an impossibility. If the two are considered together, new light is cast on the idea of

---

[5]Rice, "Statistical Quality Control, What It Is and What It Does," p. 6.

[6]E. L. Grant, *Statistical Quality Control* (New York: McGraw-Hill Book Company, 1946), p. 15.

[7]Rice, *Control Charts for Factory Management*, pp. 2-3.

[8]Grant, *op. cit.*, p. 3.

a "standard" of production. "By coupling these two concepts it becomes apparent to management that a standard is pretty well fashioned by the process itself, after all assignable causes of defection are removed. It is not something to be imposed arbitrarily by personal will."[9]

There are three steps in a statistical quality control program. First of all, there is the specification of what is wanted; secondly, the production of things to satisfy the specifications; and thirdly, the inspection of the things produced to see if they meet specifications.[10] Statistical methodology in each of these steps can play an important part in attaining relative uniformity in quality of manufactured product. In the first step, statistical methodology yields a concept of a statistical state constituting a limit to which one may hope to go in improving the uniformity of quality; in the second step, as an operation or technique of attaining uniformity; and in the third step, as a judgment.[11]

The main objectives of statistical analysis in quality control have been summarized by Juran, as follows:

> "(1) To observe and appraise the quality of finished product and to discover the extent of failures to conform to specification.
>
> (2) To trace failures in the finished product to the raw material or process by which the product is made.
>
> (3) To provide means of keeping manufacturing processes under control, to give warning of any changes from their ordinary patterns of fluctuation, and to aid in identifying the causes of such changes.
>
> (4) To judge between available processes or means for reducing variations in quality.
>
> (5) To compare the available methods of measuring quality characteristics so that they may be estimated as accurately and inexpensively as possible."[12]

The central point of argument in favor of the use of statistical quality control made so far has been the substitution of objective tests of measurement and sampling for the more extensively used

---

[9]D. L. Lobsinger, "Some Administrative Aspects of Statistical Quality Control," *Industrial Quality Control*, X (May, 1954), p. 24.

[10]W. A. Shewhart, *Statistical Method from the Viewpoint of Quality Control* (Washington: Graduate School, Department of Agriculture, 1939), p. 1.

[11]*Ibid.*

[12]J. M. Juran, *Quality Control Handbook* (New York: McGraw-Hill Book Company, 1951), p. 536.

subjective tests. This objectivity is the primary contribution on the part of statistical quality control, and it has been recognized by those persons who have had the foresight and willingness to apply it. "Where production and service processes are concerned, statistical quality control has done more to clear haziness and indecision from the minds of management than any other technique developed in the past century."[13]

HISTORY OF STATISTICAL QUALITY CONTROL

Before beginning the actual history of the development of statistical quality control, it would be advisable to make mention of the changing philosophy of statistics which served as the groundwork for statistical quality control. Prior to the early 1920's most statistical thought was associated with averages, or measures of central tendency. Little attention was paid to variation, or dispersion, as such. In the early 1920's attention was drawn to this matter of variation, and as the fundamentals of statistical quality control developed, variation became the matter of prime concern. This change "promoted" the concept of variation from a necessary evil, about which and from which little could be determined, to the most important factor, which serves as the basis of the entire field of statistical quality control.

The most fruitful use of any statistical method in the search for production uniformity, prior to 1924, is found in the work of Karl Daeves, who referred to his work as "average values based on data obtained from a large number of observations." Daeves' work was purely of an elementary nature, at least as far as the modern field of statistical quality control is concerned. It should be emphasized that prior to 1924 any attempt to recognize variation as the keynote of statistical problems in industry was strictly a minority viewpoint.

The first usages of statistical methods in quality control were during the second and third decades of the twentieth century. The pioneer in America was W. A. Shewhart of the Bell Telephone Laboratories. The development of this new technique was not an overnight process since opposition is extremely great in any case where change is contemplated. In this particular case opposition was even greater because of the statistical nature of the change.

---

[13]Lobsinger *op. cit.*, p. 20

People, in general, in those days, as well as today, were wary of statistical devices until such were proved. In spite of this opposition, the interest in statistical quality control developed at a fairly rapid pace because of two important factors. First of all, there was the rapid growth in standardization in which statistical quality control can play an important part. Secondly, as has been indicated, there was a radical change in ideology shortly after 1900. This change was from the idea of exactness of science to the idea of probability and statistical concepts which began to be found to some extent in most fields in the early 1900's.

The principal notions conceived by Shewhart remained to be proved and validated, and this was done by extensive testing programs carried on by the staffs of both the Bell Telephone Laboratories and the Western Electric Company over a number of years following this inception stage.

During the beginning of the third stage of development of statistical quality control, outward signs of progress were few. There were not many publications, little industrial activity, and little activity in the educational field. However, an extremely important development was beginning during this period in the armed services. General L. E. Simon made important contributions to the practical aspects of quality control and was instrumental in getting the armed forces to promote nationwide use of statistical control, which was of material assistance to the armament and procurement program. In addition, during the 1930's there was the beginning of the organization of professional and industrial groups interested in the furtherance of statistical quality control. By 1940 the tempo of activity was stepped up considerably as a result of these organizations. The years 1940-45 saw a tremendous increase in publications, practical applications, and educational developments, all of which can be directly attributed to the groundwork laid in the fourth decade of the twentieth century. All of these developments gave testimony to the establishment of the field as a working scientific methodology.

In the years following 1945, the best indication of the development of statistical quality control is the widespread application of the methodology in the industrial society. These applications illustrate the point that the basic concepts developed by Shewhart as a philosophical conception of the scientific method in answer to a

particular industrial problem have mushroomed into a working discipline which is now an integral part of our culture.[14]

SIMILARITY OF PROBLEMS OF QUALITY CONTROL IN NON-MANUFACTURING WORK TO PROBLEMS IN INDUSTRY

Since most of the applications of statistical quality control have been made in the factory, it is necessary first of all to examine the similarities which are found between problems in the office and problems in the factory. If sufficient similarity can be discovered, then there is the possibility of adapting much of the technique previously applied in the factory to the office procedure, together with many of the benefits found to accrue through factory application.

It is only natural that the first applications of statistical quality control would be made under manufacturing conditions since such conditions represent the birth of the product. It is possible to extend this concept to work done anywhere in the entire organization. Whereas the first applications were made in the realm of direct material and direct labor costs, undoubtedly there are possibilities in the realm of overhead cost, as well as in administrative and selling costs. With this in mind, the next step is to point up general and specific similarities of conditions in the office and in the factory.

The fact that few applications of statistical quality control in the office have been made is occasioned by two elements. First, as mentioned above, prime consideration has always been given to the manufacturing phase of a business. Second, the retardation has been furthered because of the viewpoint that some types of office work are generally not suited to such control devices. One point made in support of such a contention is that it is extremely difficult to determine whether or not a typed letter is satisfactory, and because of that, quality control would not be feasible. The contention of inapplicability of statistical quality control, however, is not true of all office work. Obviously, work such as extensions on accounts receivable ledgers and on inventory sheets, to mention only two, offer possibilities for quality control. As one writer has indicated, "quality control in the office generally means

---

[14]S. B. Littauer, "The Development of Statistical Quality Control in the United States (concluded)," *The American Statistician*, V (February, 1951), p. 17.

accuracy control."[15] Other writers in the field have maintained that there are strong possibilities for cost-saving by statistical quality control in office procedures.

Now that the general similarity of the problems has been indicated, some specific factors should be mentioned to make the case more concrete. These factors have been summarized in the following manner:

Similarities Between Machine Operations and Human Operations

Machine Operations	*Human Operations*
Scrap (or rework)	Throwbacks (for correction)
Repetition of defective parts	Repetition of same type of error
Specifications	Goals
Major and minor defects	Errors affecting and errors not affecting the customer[16]

It will be noted from this presentation that the major concepts underlying the application of statistical quality control in connection with machine operations have parallel concepts in connection with human operations, i.e., office procedures. For example, if excessive scrap or rework slows down production and adds to production costs, obviously similar increased costs will result from throwbacks of office forms and reports which are erroneously filled out or computed. If statistical quality control, through its ability to indicate the general area of error possibility in machine work, can work to lower scrap and rework, and thereby reduce costs of production, the same thing may be applied in the office in the detection and prevention of errors by one individual or group of individuals, with resultant improved work and lower office costs. In manufacturing applications, statistical quality control can make a definite contribution in the area of improving specifications. In many cases of office procedure, it is then possible to reduce the allowable error if a statistical quality control system indicates that the natural error tolerances of a procedure are less than those presently deemed to be allowable. Finally, in the plant, there is the idea of major and minor defects. In connection with acceptance

---

[15]R. B. Shartle, "How Scientific Sampling Controls Accuracy in Invoicing," *Journal of Accountancy*, XCIV (August, 1952), p. 167.

[16]J. M. Ballowe, "How Will Quality Control Reduce Costs?", *Developments in Production and Management Engineering*, printed by the American Management Association, 1945, p. 29.

sampling as used under the Army Service Forces plan, the classification below is set up.

> "*Critical* defects required 100 per cent inspection by army inspectors. They were defects that were likely to result in injury to personnel using or handling the material or in tactical defeat or serious loss in combat.
>
> *Major* defects were those likely to result in the failure of the article to function as intended but not in danger to personnel or in loss of an engagement.
>
> *Minor* defcts were those likely to cause the article to function with reduced effectiveness or to interfere with subsequent assembly or repair.
>
> *Incidental* defects were deviations from good workmanship or from specified requirements of the type that would probably have no effect on the functioning, assembly, use, interchangeability, repair, or life of an article."[17]

It seems likely then, that a similar classification of defects could be derived with regard to office procedure. It would be possible to consider major defects as those affecting the customer and minor defects as those not affecting the customer. In the case of accounts receivable, if an error is made in computing the balance of John Smith's account, the error will affect John Smith upon receipt of the statement of account receivable. On the other hand, if an error is made in cumulating all the accounts receivable balances for balance sheet purposes, the effect is on the company alone.

What, then, are the objectives of such a program of statistical quality control? Would they resemble the objectives of such a program adapted to the factory? The following summary of objectives can be applied to either the office or the factory.

> "Among the objectives of a statistical quality control program are:
> (1) To lower costs by reducing waste of labor and materials.
> (2) To improve quality and make quality more uniform.
> (3) To increase production.
> (4) To predict impending trouble.
> (5) To set, and if necessary, adjust tolerances or specifications.
> (6) To improve employee morale.
> (7) To improve customer-vendor relationships."[18]

Specifically, in the office, these objectives might be considered

---

[17]Grant, *op. cit.*, pp. 398-9.
[18]Ballowe, *op. cit.*, p. 26.

in the following manner. The reduction of waste labor and materials, resulting in lower costs, would follow from a saving of inspection time, of paperwork for re-doing faulty work, and of time spent by the worker in actually re-doing the faulty work. The improvement of quality should result in the same manner in the office as in the factory—i.e., the program should make the employees "quality-conscious." Increased production would follow from the institution of adequate training methods. Also, the possibilities of greater efficiency of work would result in increased production. The setting and adjusting of tolerances would come about as a result of considerations of standards of performance and recent data on the procedure. The idea of improving employee morale, while reasonably difficult at first, would come about with the viewpoint that a bonus could be paid for excellent work, and the idea that the entire scheme is open and above board. Correction would be made, not for the purpose of chastising one or two employees, but for the purpose of improving the work of an entire group or department. The improvement of customer-vendor relationships would result from more accurate work with regard to statements sent to the customers and also from reduced costs to the customers through savings in overhead.

Thus, it may be seen that the objectives of a statistical quality control program in the office are much the same as a similar program instituted in the factory. Accordingly, many of the benefits which have been found to accrue in the factory may be expected in the office.

GENERAL APPLICABILITY TO NON-MANUFACTURING WORK

As stated in the previous section, there are numerous objectives in the installation of a statistical quality control program in the office. In addition to the ones stated there, the over-all objectives are twofold: first, the providing of a management tool for the supervisory staff; and second, the furnishing of top management with an independent appraisal of the work being done within the office organization.[19]

There are three general areas in which an adaptation of statistical quality control might be made in the office. The areas in general are (1) the setting of norms and action limits for clerical

[19]B. B. Murdock, "Some Aspects of Quality Control as Applied to Clerical Operations," *Industrial Quality Control,* VII (May, 1951), p. 39.

work, (2) the evaluation of sales and territories, and (3) the budgetary and cost accounting records.[20]

There are many factors which bring about erroneous work on the clerical level. Many of them would be more difficult to identify than would be factors in the factory, although in some cases the basic factors are similar. For example, if an employee has a severe headache, he will do poorly, whether his work is assembling a product on the line or doing routine clerical work. H. L. Jones has classified a group of probable causes of error in clerical work as follows:

"Systematic errors:
(1) Faulty instruction.
(2) Impairment of sight.
(3) Impairment of hearing.
(4) Nervousness.
(5) Mental sluggishness.

Accidental errors:
(1) Poorly designed work papers.
(2) Poor lighting or ventilation.
(3) Noisy or defective office equipment.
(4) Improper seating.
(5) Bad posture.
(6) Impaired eyesight.
(7) Illness.
(8) Improper eating habits.
(9) Undernourishment.
(10) Emotional strain.
(11) Mental or physical fatigue.
(12) Inexperience.
(13) Carelessness."[21]

In the classification given above, a systematic error is considered as one that results from a lack of understanding as to how the work should be performed, and an accidental error is considered as one resulting from inattention, fatigue, and like causes. From a survey of these factors, it will be noted that some of them would be relatively easy to discover, while others would be extremely difficult to determine. Nevertheless, the identification and correction of such facts is essential to the efficient

---

[20]W. B. Rice, "Quality Control Applied to Business Administration," *Journal of American Statistical Association,* XXXVIII (June, 1943), pp. 231-2.

[21]H. L. Jones, "Sampling Plans for Verifying Clerical Work," *Industrial Quality Control,* III (January, 1947), p. 8.

operation of any organization, and the help given by statistical qaulity control may be enormous.

One of the first problems which must be solved in the installation procedure is the definition of "acceptable" work and "unacceptable" work. There would undoubtedly be a great degree of variation from one adaptation to another. For example, work which extends to the customer should be more closely restricted as to error than work which is purely internal in character. This is not to say that accuracy in one case should exceed that in another case as a matter of desirability, but rather as a matter of expediency. "Acceptable" work for customer invoices would be perhaps more stringently defined than "acceptable" work for intra-office records. In any case, the starting point of such a program should be the realization that variation will be inevitable. Perfect work cannot be expected to continue for any length of time. Perhaps through verification and re-verification *most* of the errors which occur in original computations can be eliminated. Perfect work cannot be guaranteed even with the use of several checks, because the human element must be depended upon for this verification, at least partially; and humans continue to be fallible. The main contribution in a statistical program is to answer the question, how large a variation in quality of work should be tolerated before some action is deemed necessary? In general, the unacceptable quality level may be set at roughly two or three times the value of the acceptable quality for a starting point. The procedure is to set the unacceptable level at the point below which it is undesirable from such viewpoints as cost, customer relationships, and employee morale. The goal set up for acceptable work, on the other hand, should be one that can reasonably be expected to be attained by a workman suitable for the job in a reasonable period of time. As circumstances vary, it will be found necessary to adjust these values from time to time, depending upon results shown by recent data, and also there is the possibility that different quality levels will be necessary according to the degrees of experience of the clerks. That is to say, there could be one level for experienced clerks, and another for inexperienced clerks.

The idea of "acceptable" and "unacceptable" quality levels of work is only one of the underlying problems to be considered in the institution of a statistical quality control program. Other important factors having to do with the actual sampling plan are

(1) regularity, (2) randomness, and (3) thoroughness. The first of the factors, regularity, has to do with the continuity of the sampling plan. It would not be advisable to sample one day, then forget about the plan for the next day or two, and then sample another day. Unless information is available every day, it is possible that assignable causes of variation may enter the process and leave undetected. The second factor, randomness, is extremely difficult to provide, at least on a theoretical basis. One definition of a random sample is: "A sample is random if each item is drawn independently of each other item and if each item has the same probability of being selected."[22] The usual way in which randomness is assured is by the use of a table of random numbers. The practical barrier to this procedure is the necessity for assigning numbers to each unit produced, and then the selection of the units to be sampled, all of which might consume more time than would be expedient. There are more practical methods whereby a reasonable degree of randomness may be provided without the loss of undue time and trouble. The third factor, thoroughness, may be insured by having as inspectors only persons who have a full knowledge of all details associated with the work of that department.

After the important factors listed above have been considered and incorporated into the specific plan to be used within a given organization, what are the benefits to be expected? What can the system of quality control add that previously did not exist?

> . . . in addition to the time savings experienced by using sample verification techniques, the following are among other benefits observed:
>
> (1) An improvement in quality of work due to the psychological effect of the visible control chart on all employees.
>
> (2) A quicker indication of specific types of errors and the reasons for them.
>
> (3) Greater confidence on the part of supervisors in the quality of work their people are doing.
>
> (4) Management's ability to determine at a glance the current quality level of the department's work.
>
> Finally, there is also the possibility of savings due to methods or system improvements made as a result of investigating 'out-of-control' situations appearing on the control chart.[23]

Of the benefits mentioned above, the importance of the first

[22]F. E. Croxton and D. J. Cowden, *Practical Business Statistics* (second edition: New York: Prentice-Hall, Inc., 1948), p. 349.
[23]Shartle, *op cit.*, p. 171.

cannot be minimized. Some grievances and disappointments are to be expected upon the initial application. However, through adopting a positive rather than a negative viewpoint, the supervisor in charge can impress the employees with the underlying psychology of the method. The basic procedure should consist in teaching the employees that the main interest of the program is to help individuals to improve, not to catch them in mistakes, or to prove that they are necessarily at fault.[24] This viewpoint, plus the placing of the control chart in view of all employees, can do much to "sell" the employees on the idea of statistical quality control.

There are many applications of statistical quality control which have been made in clerical areas. The following list summarizes some of the more important and representative applications.

John Neter, writing in the *Journal of the American Statistical Association,* lists several examples:

(1) Deming and Geoffrey used statistical techniques in controlling clerical accuracy in the Census Bureau.

(2) Alden's Inc., a mail order house, applied control chart techniques to filling of customers' orders in one of its merchandise departments. More recently, this same company has extended the technique to its general office functions as well as to the credit department.

(3) The Illinois Bell Telephone Company has used a group-sequential sampling plan for verifying clerical work in its accounting department.

(4) The Standard Register Company applied a single-sampling plan to the control of accuracy of its sales invoices.

(5) United Air Lines applied the control chart technique to controlling the accuracy of recording plane reservations.

(6) The Chesapeake and Potomac Telephone Company has applied statistical sampling techniques to accounting records to audit the classification of trouble reported by subscribers.[25]

Other cases in which a statistical quality control program has been successful are:

(7) Deer and Company applied statistical control to warehouse handling costs and saved fifty per cent of previous costs. Also,

[24]E. H. Robinson, "Building Morale Through Quality Control," *Industrial Quality Control,* VIII (May, 1952), p. 64.

[25]John Neter, "Some Applications of Statistics for Auditing," *Journal of American Statistical Association,* XLVII, (March, 1952), pp. 6-24.

they have used such control on salesmen expense accounts, inventory turnovers, receivables, and sales.[26]

(8) Curtiss-Wright Company in World War II saved $155,000 a year by cutting its daily paper load from 16,000 sheets to 920 sheets. Other applications of statistical quality control in this particular plant resulted in a total saving of $350,000 a year.[27]

From a survey of the preceding information, it becomes apparent that the institution of statistical quality control may result in saving in time and expense to the company. The specific benefits that were experienced in two applications, in addition to the factors of time and expense, are listed below.

J. M. Ballowe, discussing the applications made in a mail order house, lists the following positive benefits:

(1) Improved service to customers.
(2) Reduced errors.
(3) Aided supervision.
(4) Improved training programs.
(5) Provided continuous knowledge of performance quality.
(6) Encouraged personnel pride in performance.[28]

H. L. Jones, describing applications made in the Illinois Bell Telephone Company, points up the outstanding advantages of the statistical method:

(1) The approach is analytical.
(2) Variation is recognized.
(3) Employees derive confidence.
(4) Need for quality control is ever present.
(5) Inspection results become productive.
(6) Employee reaction is favorable.[29]

Thus, it may be seen that in spite of original hurdles, such as unfavorable employee reaction, in the installation of the system, the results far outweigh those hurdles. In the long run, the employees themselves realize the advantages of being rewarded for good performance, and with such realization, the increased production forthcoming on their part, more than compensates for any bonus which might be paid for such increased efficiency. If the bonus expense exceeded the increased production, the plan would be discontinued.

---

[26]R. K. Mueller, "Statistical Control Aids Management by Exception," *Bulletin of National Association of Cost Accountants,* XXXIV (June, 1953), p. 1303.

[27]*Ibid.*

[28]Lobsinger, *op. cit.,* p. 20.

[29]J. M. Ballowe, "Statistical Quality Control of Clerical and Manual Operations," an address presented at the Fifth Midwest Conference, American Society for Quality Control, June 1 and 2, 1950.

SUMMARY

The underlying purpose of this paper was to examine the nature of applications of statistical quality control which have been made in manufacturing activities to determine the possibility of making similar applications to non-manufacturing activity. If preliminary analysis disclosed sufficient similarity of conditions, applications to non-manufacturing activity, or more specifically, to accounting procedures, might be carried out.

In making such a comparative analysis, one of the first steps was a consideration of the requirements for the application of statistical quality control in manufacturing activities and a determination of the general benefits attainable through the successful institution of such a plan. By developing parallel requirements and benefits possible in a non-manufacturing application of statistical quality control, a decision was made as to the likelihood of a somewhat similar plan of attack.

The requirements for the use of statistical quality control in the factory may be summarized in one statement. The operation should be a repetitive, independent, functional operation affected by as few factors as possible. If these conditions are present, the scheme of statistical quality control can operate to provide benefits to a greater extent than if other conditions are found.

Among the benefits to be expected from the general application of statistical quality control in manufacturing areas are the following:

(1) Reduction in scrap work and faulty parts.
(2) Increase in "quality-mindedness" of operators.
(3) Greater quantity of improved quality material.
(4) More scientific inspection procedure.
(5) Reduction in cost of inspection.
(6) Authentic record of the quality of the product.

It was discovered that many of these requirements and benefits exist or could be expected in accounting areas of a business organization as well as in the manufacturing sectors. Consider, for example, the procedures of preparing and verifying an accounts receivable invoice. Assuming that the business is of reasonable size, the operation would fulfill the requirement of being repetitive. Probably the work of preparing and the work of verifying would be independent of each other. In addition, each operation would be independent of other operations, at least during the time in which preparation or verification is being carried out. Each of the operations would be functional in that only one purpose is

accomplished in the preparation and in the verification. Few factors would affect each operation. In the preparation of the accounts receivable invoice, the calculations would consist perhaps of an extension of a unit price times the quantity, the addition of a number of extensions, the calculation of a discount and the net sales price. In the verification of the invoice, the same procedure would be followed, depending upon the extent of the verification desired.

Benefits similar to those resulting from the application of statistical quality control to manufacturing activities might be expected from the application to accounting procedures. A reduction in scrap work and faulty parts would be paralleled by a reduction in error rate and incorrect invoices. The accounting personnel themselves could become more "quality minded." Such an attitude could result in a greater quantity of higher quality work. By the use of statistical sampling schemes the verification procedure would be made more scientific, with a possibility of reduced work load to produce a desired degree of accuracy. With a reduced work load of inspection, the costs of verification would be reduced in proportion. Lastly, the plan would provide an authentic record of the quality of the work done by the personnel.

Applications of statistical quality control have been made in the non-manufacturing areas of business. Applications such as clerical accuracy in the Census Bureau, filling of mail orders, controlling clerical accuracy of sales invoices, controlling the accuracy of airplane reservations, and reducing warehouse handling costs have been successfully made by various business organizations. The variety of applications indicates that possibilities do exist for the application of statistical quality control in the general area of accounting problems.

One of the outstanding opportunities for application is in the area of auditing. There are available a number of sampling plans, which may be derived on a scientific basis, and which would improve the work of the auditor, whether on an internal or external basis.

When the costs of statistical quality control are weighed against the resulting benefits, the application in accounting areas should increase. Eventually there should be an even greater volume of applications in the non-manufacturing area than in the manufacturing area. The possibilities will be limited solely by individual imagination and the willingness of management to have such applications made.

BIBLIOGRAPHY

A. Books

Croxton, F. E., and D. J. Cowden, *Practical Business Statistics,* Second Edition, (New York: Prentice-Hall, Inc.), 1948.

Feigenbaum, A. V., *Quality Control: Principles, Practice, and Administration,* (New York: McGraw-Hill Book Company), 1951.

Grant, E. L., *Statistical Quality Control,* (New York: McGraw-Hill Book Company), 1946.

Juran, J. M., *Quality-Control Handbook,* (New York: McGraw-Hill Book Company), 1951.

Rice, W. B., *Control Charts in Factory Management,* (New York: John Wiley & Sons, Inc.), 1947.

Shewhart, W. A., *Statistical Method from the Viewpoint of Quality Control,* (Washington: Graduate School, Department of Agriculture), 1939.

B. Periodical Articles

Jones, H. L., "Sampling Plans for Verifying Clerical Work," *Industrial Quality Control,* III, 1947.

Littauer, S. B., "The Development of Statistical Quality Control in the United States," *The American Statistician,* IV, 1950.

————"The Development of Statistical Quality Control in the United States (concluded)," *The American Statistician,* V, 1951.

Lobsinger, D. L., "Some Administrative Aspects of Statistical Quality Control," *Industrial Quality Control,* X, 1954.

Mueller, R. K., "Statistical Control Aids Management by Exception," *Bulletin of the National Association of Cost Accountants,* XXXIV, 1953.

Murdock, B. B., "Some Aspects of Quality Control As Applied to Clerical Operation," *Industrial Quality Control,* VII, 1951.

Neter, John, "Some Applications of Statistics for Auditing," *Journal of the American Statistical Association,* XLVII, 1952.

Rice, W. B.,"Quality Control Applied to Business Administration," *Journal of the American Statistical Association,* XXXVIII, 1943.

———————. "Statistical Controls Applied to Financial Statements," *The Accounting Review,* XXI, 1946.

Robinson, E. H., "Building Morale through Quality Control," *Industrial Quality Control,* VIII, 1953.

Shartle, R. B., "How Scientific Sampling Controls Accuracy in Invoicing," *The Journal of Accountancy,* XCIV, 1952.

C. Pamphlets and Addresses

Ballowe, J. M., "How Will Quality Control Reduce Costs?" *Developments in Production and Management Engineering,* 1945.

———————. "Statistical Quality Control of Clerical and Manual Operations," an address presented at the Fifth Midwest Conference, American Society for Quality Control, June 1 and 2, 1950.